Practitioner's Docket No. 200-009119-US(PAR) 12/23/99 **PATENT**

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Peter SLADEN

WARNING: 37 C.F.R. § 1.41(a)(1) points out:

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors."

For (title): IMAGE SENSOR

CERTIFICATION UNDER 37 C.F.R. § 1.10*
(Express Mail label number is mandatory.)
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date December 22, 1999, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL067144355US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Maureen Egan
(type or print name of person mailing paper)

Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

**WARNING: Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).*
Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

1. **Type of Application**

This new application is for a(n)

(check one applicable item below)

☒ Original (nonprovisional)

☐ Design

☐ Plant

WARNING: Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. § 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

WARNING: Do not use this transmittal for the filing of a provisional application.

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

☐ Divisional.

☐ Continuation.

☐ Continuation-in-part (C-I-P).

2. **Benefit of Prior U.S. Application(s)** (35 U.S.C. §§ 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. § 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(l) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a C-I-P application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

__9__ Pages of specification

__2__ Pages of claims

__2__ Sheets of drawing

WARNING: DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. § 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. § 1.84(c)).

(complete the following, if applicable)

☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. § 1.84(b).

☐ formal

☐ informal

B. Other Papers Enclosed

_____ Pages of declaration and power of attorney

__1__ Pages of abstract

_____ Other

4. Additional papers enclosed

☐ Amendment to claims

☐ Cancel in this applications claims _____ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☐ Preliminary Amendment

☒ Information Disclosure Statement (37 C.F.R. § 1.98)

☒ Form PTO–1449 (PTO/SB/08A and 08B)

☒ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)–(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)–(4).

☐ Enclosed

Executed by

(check all applicable boxes)

☐ Inventor(s).

☐ legal representative of inventor(s). 37 C.F.R. §§ 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. § 1.47 and the statement required by 37 C.F.R. § 1.47 is also attached. *See* Item 13 below for fee.

☒ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☒ Application is made by a person authorized under 37 C.F.R. § 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 C.F.R. § 1.16(e) can be filed subsequently).

☐ Showing that the filing is authorized.
(not required unless called into question, 37 C.F.R. § 1.41(d))

6. Inventorship Statement

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of $130.00 required by 37 C.F.R. § 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 C.F.R. § 1.52(d).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. § 1.52(d).

8. Assignment

☒ An assignment of the invention to Nokia Mobile Phones Ltd.

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "CERTIFICATE UNDER 37 C.F.R. § 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
United Kingdom	9828544.8	23 December 1998
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☒ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. § 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. § 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. § 1.16)

A. ☒ Regular application

CLAIMS AS FILED					
Number filed		Number Extra		Rate	Basic Fee 37 C.F.R. § 1.16(a) $760.00
Total Claims (37 C.F.R. § 1.16(c))	10 – 20 =	0	×	$ 18.00	0
Independent Claims (37 C.F.R. § 1.16(b))	1 – 3 =	0	×	$ 78.00	0
Multiple dependent claim(s), if any (37 C.F.R. § 1.16(d))			+	$260.00	

☐ Amendment cancelling extra claims is enclosed.

☐ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. § 1.16(d).

Filing Fee Calculation $ 760.00

B. ☐ Design application ($310.00—37 C.F.R. § 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application ($480.00—37 C.F.R. § 1.16(g))

Filing fee calculation $_____

11. **Small Entity Statement(s)**

☐ Statement(s) that this is a filing by a small entity under 37 C.F.R. § 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. § 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).

WARNING: "Small entity status must not be established when the person or persons signing the . . . statement can unequivocally make the required self-certification." M.P.E.P., § 509.03, 6th ed., rev. 2, July 1996 (emphasis added).

(complete the following, if applicable)

☐ Status as a small entity was claimed in prior application

_____ / _____, filed on _____, from which benefit is being claimed for this application under:

35 U.S.C. § ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of **A, B** or **C** above)

$_____

NOTE: Any excess of the full fee paid will be refunded if small entity status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 C.F.R. § 1.28(a).

12. **Request for International-Type Search** (37 C.F.R. § 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. § 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee $ 760.00

☐ Recording assignment
($40.00; 37 C.F.R. § 1.21(h))
(See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".) $ _____

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached
($130.00; 37 C.F.R. §§ 1.47 and 1.17(l)) $ _____

☐ For processing an application with a specification in a non-English language
($130.00; 37 C.F.R. §§ 1.52(d) and 1.17(k)) $ _____

☐ Processing and retention fee
($130.00; 37 C.F.R. §§ 1.53(d) and 1.21(l)) $ _____

☐ Fee for international-type search report
($40.00; 37 C.F.R. § 1.21(e)) $ _____

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as the changes to 37 C.F.R. §§ 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed $ 760.00

14. Method of Payment of Fees

☒ Check in the amount of $ 760.00

☐ Charge Account No. _____ in the amount of $_____.
A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. § 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing, the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 16-1350 :

☒ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)

☒ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☒ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a)).

☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: ". . .A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

☐ 37 C.F.R. § 1.18 (Issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . ." From the wording of 37 C.F.R. § 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: ". . . Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ Credit Account No. 16-1350

☐ Refund

SEND ALL CORRESPONDENCE TO:

SIGNATURE OF PRACTITIONER

Reg. No. 24,622

Clarence A. Green

(type or print name of attorney)

Tel. No. (203) 259-1800

PERMAN & GREEN, LLP

P.O. Address

Customer No.

425 Post Road, Fairfield, Connecticut 06430

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an International application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

☒ This transmittal ends with this page.

Image Sensor

Background of the Invention

The present invention relates to video image sensors, and more particularly to colour and light sensing in relation to such sensors.

Red, green and blue (RGB) are three primary additive colours whereby individual components are added together to form a desired colour and this format is the basic colour space model which is widely used throughout imaging. In particular, broadcast, video and imaging standards make use of RGB signals to derive luminance and colour difference video signals, such as YUV, YIQ or YCbCr colour spaces. Colour spaces are mathematical representations of a set of colours. In YUV, Y represents the black and white information in the video signal (i.e. luminance), and U and V represent the colour information in the video signal (i.e. chrominance). The basic equations for converting between RGB and YUV are:

$$Y = 0.299R + 0.587G + 0.114B$$
$$U = -0.147R - 0.289G + 0.436B$$
$$U = 0.492(B - Y)$$
$$V = 0.615R - 0.515G - 0.100\mathrm{B}$$
$$V = 0.877(R - Y)$$

In YIQ colour space, I stands for in-phase and Q stands for quadrature, which is the modulation method used to transmit the colour information; YIQ can be derived from YUV. YCbCr is a scaled and offset version of the YUV colour space.

Currently, in known colour video sensing devices such as video cameras, black and white pixel sensors are adapted to read colour information by disposing colour filters over the sensors, which sensors typically are CCD or CMOS sensors. A standard arrangement is for the pixels to be grouped in 2 x 2 blocks, with diagonally opposite pixels being responsive to green light and the other two diagonally opposite pixels being responsive to blue and red light respectively. These are known as RGB filters. The reason why there are two green pixels is that more image information is present in green light.

It has been noted that a problem of using such an arrangement of RGB filters is that it introduces a light attenuation of approximately 50:1. The share of the pixels between green, blue and red filters means that there is only 25% of the black and white pixel sensors for each of the blue and red filters, and 50% for the green filters. The result is that the sensor loses a great deal of colour resolution. Attempts are made in the downstream processing of the sensor output to recover the original resolution and a common technique is interpolation of the sensor output information using complex proprietary algorithms. This in essence involves estimating by interpolation what the colour response might be at a given pixel location based on the sensor outputs from the pixels surrounding that given pixel. However, since interpolation is a very approximate calculation its effectiveness varies widely depending on the complexity of the algorithm.

In addition, use of RGB filters leads to a reduction in sensitivity. Furthermore, there is also a reduction in the spatial resolution of the sensor, RGB colour filtering reducing resolution approximately by a factor of four.

A solution to the problem of loss of sensitivity due to RGB filters is to increase the length of time that the sensors are exposed to the scene to be captured on video. However, the knock-on effect of this is that the camera is more

susceptible to shaking, and also blurring due to subject movement is more likely to occur. This is a particularly marked problem for CMOS sensors which are of much lower sensitivity than CCD sensors. Also, since sensor noise is additive, longer exposure periods results in higher noise floor, and thus the image signal is swamped.

As mentioned previously, in general, resolution of the image is determined by interpolation. Since there are a greater number of pixels in the green colour band and since also green light contains greater image information, this is used to increase the effective resolution of red and blue sensors. The main problem with this technique is that it is highly dependent on the quality of the algorithm used and its complexity. Sometimes the quality of the red and blue information can be improved further using green information.

Summary of the Invention

The present invention is based on the observation that the human eye is not as sensitive to colours as it is to brightness. In light of this observation, it is proposed that instead of at the pixel level having red, green and blue filters mapping onto respective pixels, certain of the colour pixels be replaced by so-called 'grey' filters in which there are no colour filters associated with such pixels. Accordingly, the present invention resides in an image sensing device having an array of image sensors and a filter structure disposed in relation to the image sensors, the filter structure comprising blocks of filter groups, each group having a combination of one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors with colour filtering, and one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors without colour filtering.

A key advantage of the present invention, is that because there are certain areas in the filter which will allow the incident light to pass through without any colour filtering, the attenuation of the light is greatly reduced and consequently sensitivity of the device is enhanced compared with known RGB filter image sensing devices.

A further advantage of the present invention is that it is better suited to image compression because it provides for better compatibility with such compression techniques. This is because image compression systems such as MPEG and JPEG have similar luminance and chrominance requirements to that output from the sensors of the present invention. In particular, such compression standards reduce chrominance, while sustaining the same level of luminance. Because the grey resolution and colour resolution of an image sensor of the present invention is designed to match those of MPEG and JPEG compression standards, the signals output from the sensors require a minimal amount of additional signal conditioning for JPEG and MPEG compression.

In the prior art, the sensors are in Beyer pattern and Beyer pattern causes image anomalies during conversion to RGB. At the pixel level these anomalies are not very significant because individual pixels are only marginally visible. However, when the image is enlarged, these anomalies are enlarged and spread over several pixels, thereby becoming more visible.

Since the format of the image sensor of the present invention is in line with DCT (discrete cosine transform) based compression techniques, it will better scale when enlarged. Therefore, by means of the invention it is possible to use a lower pixel sensor count, and scale to produce similar quality to a larger pixel count Beyer sensor.

A further advantage is that since there is a direct measure of luminance by virtue of those areas of the filter where there are no colour filters, the grey pixels of the present invention offer a full resolution of the image and therefore there is a significant improvement in image quality.

Additionally the image sensor calculation of YUV is much simplified over known prior art systems.

Brief Description of the Drawings

The present invention will now be described by way only of example with reference to the accompanying drawings in which:

Figure 1 schematically illustrates a first embodiment of the present invention;
Figure 2 schematically illustrates a second embodiment of the present invention; and
Figure 3 schematically illustrates a third embodiment of the present invention.

Detailed Description of the Invention

Referring initially to Figure 1, there is shown a filter group of a unitary block (10) from a repeating pattern of such blocks forming a filter structure in accordance with a first embodiment of the present invention. The filter structure is overlaid in relation to an array of pixel sensors of a video imaging device. The block (10) consists of six filter areas. Four of these are areas in which there are no colour filters overlaying the respective pixels and these are denoted Y (for ease of reference these will be referred to as grey sensors). There is one area denoted B which represents a blue filter and there is another area denoted R which represents a red filter. The Y areas conveniently are formed by apertured windows in the filter structure which

align with respective pixels sensors. In this embodiment the Y areas are generally square, although rectangular and other shapes are equally permissible, and they are arranged spaced from one another in a generally square configuration. The blue and red filters are disposed centrally in relation to the four square grey sensors and conveniently are triangular in shape, although again other shapes are equally permissible.

The process involved in capturing a video image using the filter structure of the present invention begins by first starting exposure for the red and blue filters. As mentioned above, since chrominance filters are less sensitive to light than luminance filters it is necessary to expose them for longer exposure times than luminance filters. Sensor readings are then taken from the four grey sensors by sampling them. While reading the luminance response the chrominance filters are subjected to extended exposure time. Next, the red and blue pixels are sampled. This series of steps is repeated for each block and involves reading a row of pixel sensors, resetting and looping. Typically, the refresh rate is 30 frames per second and is sequential.

Since in known RGB arrangements the green filters occupy 50% of the filter space in a 2 x 2 block, it is proposed that in this embodiment the Y areas also occupy half of the filter space in a block, and because there are a group of four Y areas in each block, this can be expressed as fraction 4/8 of the overall filter space in each block. As there is no colour filtering in these Y areas the grey sensors are 50 times more sensitive and thus the overall sensitivity of the block is increased by 4/8 x 50 giving 25 times the sensitivity of prior art RGB filters. It should be mentioned that in order to achieve the same overall area of filter block as RGB filters, as there are four Y areas in place of two green filters, the size of each of the Y areas is reduced by 50% in comparison to green filters.

It was explained above that the blue and red pixels have four times the exposure time and this produces four times the amplitude. Effective sensitivity will therefore be increased fourfold and thus could allow for a reduction in filter size over known blue and red filters.

So for this embodiment, the relative areas are four Y areas each at 1/8 of the overall size, one blue at 2/8 of the overall area and one red pixel again at 2/8 of the overall area. YUV is then given by the following set of equations:

Luminance for pixel 1	Y1 = Grey1 - 2R - 3B
Luminance for pixel 2	Y2 = Grey2 - 2R - 3B
Luminance for pixel 3	Y3 = Grey3 - 2R - 3B
Luminance for pixel 4	Y4 = Grey4 - 2R - 3B
Blue chrominance	U = 3B - (grey1 + grey2 + grey3 + grey4)/8
Red chrominance	V = 6R - 0.9 x (grey1 + grey2 + grey3 + grey4)/4

The reduction in signal amplitude for red and blue pixels is not significant, with 1/6 of full scale 12 bit (256), providing A/D values 0 to 42; this is particularly so given that image compression algorithms reduce resolution below this during quantisation. However, to correct for this there could be an increase in size of red and blue pixels, and for example doubling their filter areas would increase A/D range to 84 and affect sensitivity by 16 times that of standard RGB filtered sensors.

The above estimates are model values ignoring fill factor, which is concerned with the amount of associated silicon in the sensor chip dedicated to processing and which will effectively reduce as a result of this method. If grey pixels are same size as black/white, and fill factor is 25% for the latter, then the table below outlines the unit area for each sensor block.

	black/white	GreyRB
Pixels	4	8
Associated local circuitry	12 1	8
Total area for GreyRB	16	26
Absolute fill factor	25%	31%
Corrected fill factor*	15%	

* allowing for the fact that only four of the eight pixels are for luminance

Therefore 25 fold increase in sensitivity is likely to be 15%/25% x 25 = 15:1 increase in sensitivity. The likely increase in silicon could be 26/16 times the size, ie. 62% larger. However, the sensor array is only around 50% of the total silicon area, and therefore this equates to a 31% area increase.

Figure 2 illustrates an alternative embodiment in which the red and blue filters of the block (20) are provided in strip like bands separating pairs of Y areas disposed above and below the bands. It is envisaged that the manufacture of such a filter structure would be much simplified because the ease of forming the red and blue bands would be increased because of less stringent alignment requirements of colour filters in relation to the pixel sensors. The manner in which this embodiment works is similar to the embodiment of Figure 1, although because of the different filter structure the specific mathematics of the filter sizes and sensitivity calculations are different. Such calculations being readily derivable by those skilled in the art based on the equations provided above.

A third embodiment (30) of the present invention is illustrated in Figure 3. In this embodiment green (34) and red (32) stripped filters are disposed lengthwise across the Y areas (and grey pixels) which are disposed in a generally square configuration as in the previously described embodiments. This embodiment is similar to that of either of Figures 1 or 2 in that for each block there are four grey sensors disposed in a square configuration around

centrally disposed red and blue colour filters, the addition being that of the green and red stripped filters across the Y areas. Whilst the grey sensors in this embodiment still take a direct measure of luminance they are corrected for red and blue by the green and red strips and therefore provide a measure of luminance without the need for any calculation as required in embodiments for Figure 1 and 2. In other words, the green and blue strips correct for the influence of the central red and blue filters and accordingly yield direct Y measurements.

The present invention may be embodied in other specific forms without departing from its essential attributes. For example, different specific configurations of the various colour/non-colour areas are possible giving analogous results. Accordingly reference should be made to the appended claims and other general statements herein rather than to the foregoing specific description as indicating the scope of invention.

Furthermore, each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features. In this regard, the invention includes any novel features or combination of features disclosed herein either explicitly or any generalisation thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed.

The appended abstract as filed herewith is included in the specification by reference.

What is claimed is:-

1. An image sensing device having an array of image sensors and a filter structure disposed in relation to the image sensors, the filter structure comprising blocks of filter groups, each group having a combination of one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors with colour filtering, and one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors without colour filtering.

2. An imaging device according to claim 1, wherein said one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors with colour filtering comprise two colour filters.

3. An imaging device according to claim 2, wherein the two colour filters are one each of red and blue filters.

4. An imaging device according to claim 1, wherein said one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors without colour filtering comprise four filterless areas.

5. An imaging device according to claim 1, wherein said one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors without colour filtering comprise four non-colour filters.

6. An imaging device according to claim 1, wherein the arrangement of said areas in each block of filter groups in the filter structure comprises stripline formation of said respective areas.

7. An imaging device according to claim 1, wherein the image sensors are CMOS sensors.

8. An imaging device according to claim 1, wherein said one or more areas adapted so as to allow light to pass therethrough onto corresponding image sensors without colour filtering include one or more colour filters disposed at least partially thereover.

9. An imaging device according to claim 8, wherein said one or more colour filters disposed over the one or more areas adapted to allow light to pass therethrough without colour filtering comprise colour filter strips.

10. An image sensing device according to claim 1, wherein said colour filtering areas are disposed centrally in the filter group and said areas without colour filtering are disposed in a generally square like configuration around the central colour filters.

Abstract

This invention discloses a filter structure for a video image sensing device. The filter structure consists of a red colour filter and a blue colour filter and these are combined in a sensing block with non-colour or apertured windowed sensors i.e. grey sensors.

Figure Number 1

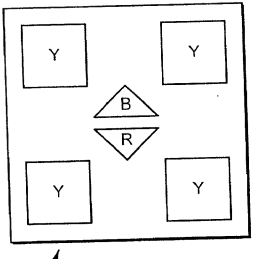

FIG. 1

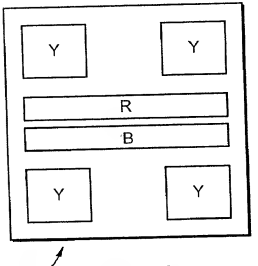

FIG. 2

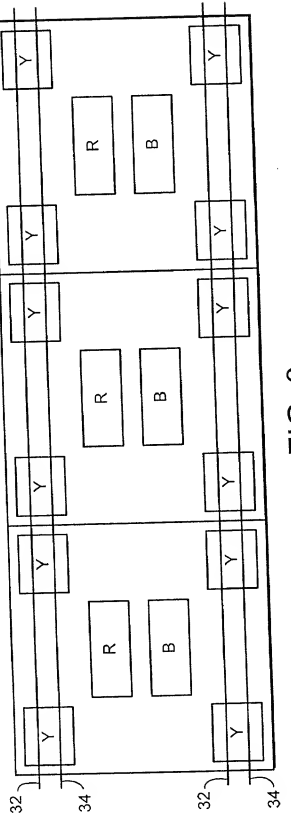

FIG. 3